



Demand-specific work ability, poor health and working conditions in middle-aged full-time employees



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ABSTRACT

We investigated the prevalence of reduced demand-specific work ability, its association with age, gender, education, poor health, and working conditions, and the interaction between poor health and working conditions regarding reduced demand-specific work ability. We used cross-sectional questionnaire data from 3381 full-time employees responding to questions about vocational education, job demands and social support (working conditions), musculoskeletal pain (MSP) and major depression (MD) (poor health) and seven questions about difficulty managing different job demands (*reduced demand-specific work ability*). Reduced demand-specific work ability varied from 9% to 19% among the 46-year old and from 11% to 21% among the 56-year old. Age was associated with two, gender with four, and education with all measures of reduced demand-specific work ability. MSP was associated with four and MD was associated with six measures of reduced demand-specific work ability. We found no interaction between working conditions and poor health regarding reduced demand-specific work ability.

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1. Introduction

Work ability reflects the balance between personal resources and job demands (Tengland, 2011; van den Berg et al., 2009). Previous studies show that both low personal resources, e.g. depressive symptoms and musculoskeletal pain, and demanding working conditions, e.g. high mental work load, high physical work load, low social support, and low work spirit, are associated with decreased work ability (Deyo and Weinstein, 2001; Elinson et al., 2004; Martimo et al., 2007; Martinez and Latorre, 2006; Miranda et al., 2010; van den Berg et al., 2008; van den Berg et al., 2009). Still, the potential interaction between low personal resources and high job demands when predicting poor work ability is seldom investigated. We hypothesize that low personal resources, as depression and musculoskeletal pain, have a larger negative effect on work ability under conditions of high job demands than under conditions of low job demands.

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Reduced work ability is not necessarily global (Tengland, 2011). An employee's work ability can be reduced with regard to certain job demands but unaffected with regard to other job demands. Additionally, different health problems may have different effects on work ability. In theory, depressive symptoms will directly affect a person's cognitive function and thereby the ability to manage cognitive work tasks (McDermott and Ebmeier, 2009), while musculoskeletal pain affects a person's physical function, which can reduce engagement in physically heavy work in order to avoid pain (McCracken and Samuel, 2007). Accordingly, we hypothesize that depression and musculoskeletal pain have different effects on the ability to manage specific job demands. However, most studies report effects on overall work ability and not the effect on the ability to manage specific job demands (van den Berg et al., 2009).

This shortage of knowledge partly stems from that the most widely used questionnaire for the assessment of work ability, the *Work Ability Index* (de Zwart et al., 2002; van den Berg et al., 2009), concerns physical and mental work ability in broad terms. It is, however, necessary to identify which job demands the employee is unable to meet, if tailored intervention is to be made, and therefore, knowledge about how health problems affect the ability to manage specific job demands is warranted.

The *Work-Limitation Questionnaire* allows for an assessment of the respondent's difficulty managing a range of physical,

psychological, and social demands (Lerner et al., 2001; Munir, 2008). Yet, it is the case for the *Work Ability Index*, the *Work-Limitation Questionnaire*, and also the *World Health Organization Health and Work Performance Questionnaire* (Kessler et al., 2003) that the respondent is asked explicitly to assess the impact of his or her health on current work ability. This leaves the appraisal of the causal relationship between health and work ability to the responder and, furthermore, it results in a circular argument when statistically analyzing the association between health and reduced work ability. Consequently, neither the separate effect of poor health nor the interaction between poor health and high job demands on work ability can be investigated properly.

To sum up, the present study intends to contribute to the literature on work ability by studying the associations of poor health with perceived difficulty managing specific job demands and by studying the interaction between poor health and working conditions in relation to perceived difficulty managing specific job demands. By means of a new questionnaire, '*reduced demand-specific work ability*' was measured as difficulty managing seven different specific job demands without asking the respondent to appraise the influence of their health. Poor health was measured as musculoskeletal pain (MSP) and major depression (MD), and working conditions were measured as job demands and social support.

More specifically, the aims of this cross-sectional study was *first* to describe the prevalence of reduced demand-specific work ability in a sample of 46-year and 56-year old full-time employees, *second* to study the association of reduced demand-specific work ability with age, gender, and vocational education; *third* to investigate the association of MSP and MD with reduced demand-specific work ability; and *fourth* to investigate the interaction between specific working conditions (job demands and social support) and poor health (MSP and MD) in relation to demand-specific work ability.

2. Material and methods

2.1. Design, data collection and study population

We used cross-sectional questionnaire data from a subsample of the 2006-survey of *The Danish Longitudinal Study on Work, Unemployment and Health* (Christensen et al., 2006).

In 2000, a random sample of individuals aged 40 or 50 years by 1st of October 1999 ($n = 11,082$, response rate 68.5%, final sample 7588) was drawn from The Danish Institute of Governmental Research Longitudinal Register. This register contains data on 10% of the Danish population aged 15 years or older. Data for the survey were collected by postal questionnaires, including two reminders for non-respondents.

In 2006, 4893 of the now 46- and 56-year old baseline respondents (64.5%) returned a follow-up questionnaire which included questions on demand-specific work ability. The subsample used in the present paper comprised the 3381 participants who indicated the length of their vocational education and who were full-time employed (>30 h per week) at the time of the data collection. The distribution of gender, vocational education, health, working condition and reduced demand-specific work ability for each age group is presented in Table 1.

2.2. Poor health (MSP and MD)

The participants were asked three questions about MSP: i) Do you have pain in the upper part of your back or neck? ii) Do you have low back pain? iii) Do you have pain in other joints (e.g., fingers, shoulders, hips, knees, or ankles)? The six response options were 'yes, daily', 'yes, a couple of times each week', 'a couple of

Table 1

Description of the participants in the two age-groups of the study. The letters in brackets (a–g) refer to the description of the variables measuring demand-specific work ability in Section 2.5.

	46-years old ($n = 1713$)	56-years old ($n = 1668$)
	Percentages (%)	
Gender		
Male	43.9	53.2
Female	56.1	46.8
Vocational education		
None	8.9	7.1
Semi-skilled worker	3.4	3.7
Skilled worker	38.4	39.9
Short education (<3 years)	11.3	11.3
Middle-ranged education (3–4 years)	27.7	27.3
Long education (>4 years)	10.3	10.7
Poor health		
MSP	21.2	27.2
Moderate to severe depression	4.4	2.7
Working conditions		
High physical job demands	13.4	11.1
High demands to accomplish high amounts of work	20.0	20.0
High demands to work fast	36.9	34.3
High demands to make quick decisions	68.9	65.5
High demands to remembering a lot of things	82.2	79.2
High emotional demands	27.8	25.7
Low social support from colleagues	62.8	57.5
Reduced demand-specific work ability (%)		
Physical (a)	14.5	18.0
Amount (b)	19.3	21.3
Pace (c)	15.5	16.9
Decision (d)	9.7	12.2
Memory (e)	12.4	14.1
Client (f)	8.9	10.8
Co-operation (g)	8.8	11.3

times each month', 'yes, but not more than once a month', 'yes, more seldom', and 'no, never'. We defined MSP cases as respondents that were severely affected by MSP, i.e. participants with daily MSP (i.e. answering 'yes, daily' to at least one of the questions on MSP) and we defined MSP non-cases as participants without daily MSP.

To measure MD we used the Major Depression Inventory (MDI) which contains a symptom list that covers the ICD-10 and DSM-IV symptoms of depression. The MDI includes 12 questions, for example, 'Have you felt low in spirits or sad? Have you felt that life wasn't worth living?' and 'Have you had trouble sleeping at night?'. The six response options ranged from 'all the time' (coded 5), 'most of the time' (coded 4), 'a slightly more than half of the time' (coded 3), 'slightly less than half of the time' (coded 2), 'some of the time' (coded 1) 'at no time' (coded 0). For each participant, a mean score was calculated according to the manual with higher scores indicating more depressive symptoms (range: 0–50) (Bech et al., 2001). Responders were dichotomized into participants with and without major depression (MD) (cut point by 26 points as recommended by Bech et al. (2001)).

2.3. Working conditions

A total of seven separate variables measuring job demands and social support were included in the study:

- 1) Physical job demands
- 2) Demands to accomplish high amounts of work

- 3) Demands to work fast
- 4) Demands to make quick decisions
- 5) Memory demands
- 6) Emotional demands
- 7) Social support.

According to the manual, the response options for all the demands questions were 'always' (coded 100), 'often' (coded 67), 'sometimes' (coded 33) and 'never' (coded 0); a higher score thus indicated a higher frequency of the demands. The response options for social support questions were 'always' (coded 0), 'often' (coded 33), 'sometimes' (coded 67), 'never' (coded 100) and 'not relevant' (the latter was excluded from analysis); a higher score thus indicated lack of social support. All variables were dichotomized by a cut-off at 50 points (i.e. the middle of the scale) into low versus high demands, and high versus low social support. This means that participants who were categorized as exposed to high demands on average responded 'always' or 'often' to the demands question. Participants who were categorized as exposed to low social support on average responded 'sometimes' or 'never' to questions on social support (those responding 'always' or 'often' were categorized as having high social support and thus considered 'unexposed' in the present study). This dichotomization of working conditions corresponds well with our definition of reduced demand-specific work ability as responding often/always having difficulties managing the specified work tasks.

The measure of physical job demands (1) originated from the *Danish Work Environment Cohort Study* (Burr et al., 2003). The measure concerned how often you work in a stooping posture, twist your back several times per hour, lift or transfer heavy objects or persons, and push or pull heavy objects (4 items).

The measures of psychosocial job demands and social support originated from the *Copenhagen Psychosocial Questionnaire* (Pejtersen et al., 2010). Demands to accomplish high amounts of work (2) concerned unevenly distributed work, insufficient time to complete work tasks, and getting behind with work (3 items). Demands to work fast (3) concerned working very fast and at a high pace throughout the day (2 items). Demands to make quick decisions (4) concerned requirements of quick decisions (1 item). Memory demands (5) concerned requirements of remembering a lot of things (1 item). Emotional demands (6) concerned emotionally demanding work (1 item). Social support (7) concerned the opportunity to get help and support from colleagues and colleagues being willing to listen to problems at work (2 items).

2.4. Demographics

We obtained information on age, gender, and length of vocational education (none, semi-skilled, skilled (e.g. carpenter), short (<3 years; e.g. market economist), middle-ranked (3–4 years; e.g. bachelor's degree), long (>4 years, e.g. physician)). These variables were included in the statistical analyses as they could potentially confound the association between MSP/MD and work ability.

2.5. Reduced demand-specific work ability

The items measuring demand-specific work ability were developed for *The Danish Longitudinal Study on Work, Unemployment and Health*, and they have not been reported previously. To estimate reductions in the demand-specific work ability of the participants, we asked 'When you think about the last two months, how often have you had difficulty doing the following in your paid employment?' followed by (we present a shortened version of the variable names in squared brackets):

- a. Managing the physical job demands (lifting, carrying, pushing, pulling, standing, bending etc.) [*physical*]
- b. Managing the amount of work [*amount*]
- c. Managing the pace of work [*pace*]
- d. Making quick decisions [*decisions*]
- e. Remembering the things that are important for your work tasks? [*memory*]
- f. Working with customers, patients, or students/pupils [*client work*]
- g. Working together with colleagues [*co-operation*]

The six response options were 'always', 'often', 'sometimes', 'seldom', 'never', and 'not relevant'. The 'not relevant' category was excluded as we intended that this response category should be used by the participant not exposed to the type of job demand that the demand-specific work disability question referred to. In total, 34.1% of the participants responded 'not relevant' to the question about difficulty managing the physical job demands and 16.3% responded 'not relevant' with respect to difficulty managing client work. The corresponding figures for the remaining work ability variables ranged from 1.7 to 4.3%. Reduced demand-specific work ability was defined as responding often/always having difficulty managing the specified work tasks.

2.6. Statistical analyses

First, we analyzed the distribution of gender, vocational education, poor health, working conditions, and the seven measures of reduced demand-specific work ability (Table 1).

Second, we estimated the mutually adjusted association of age, gender, and length of vocational education (categorical) with the seven measures of reduced demand-specific work ability in a binary logistic regression model; the estimates were also adjusted for daily MSP, MD, and specific job demands/social support (Table 2).

Third, we analyzed the association of each of the seven measures of demand-specific work ability with daily MSP and MD (mutually adjusted, Table 3). In Model I, we included MSP, MD, and age. In Model II, we included MSP, MD, age, gender, and length of vocational education. In Model III, we included MSP, MD, age, gender, length of vocational education, and the specific job demand or social support variable.

Fourth, we analyzed whether there was multiplicative or additive interaction between the specific job demand/low social support and MSP/MD regarding each of the seven measures of reduced demand-specific work ability. To test for *multiplicative interaction*, we added an interaction term (e.g. MSP*job demand or MD*job demand) to the analyses presented in Model III, Table 3 (data on interactions not shown in tables). To test for *additive interaction*, we constructed new variables combining the main exposures (MSP/MD and job demands/social support) to estimate the odds of reduced demand-specific work ability among employees, for example, (1) low physical demands + no MSP (reference); (2) low physical demands + MSP; (3) high physical demands + no MSP; (4) high physical demands + MSP. Based on the results from the analyses of the associations between these new variables and demand-specific work ability we calculated estimates of Relative Excess Risk of Interaction (RERI) and their 95% confidence intervals (Knol et al., 2011; Lundberg et al., 1996).

Cases with missing values were excluded analysis by analysis (i.e. each participant was included in the analyses where he/she had no missing values and excluded only from the analyses where he/she had missing values). All included cases had full information on age, gender, and vocational education. For all exposure variables (i.e. poor health and working conditions) ≤1.0% had missing values ($n = 25$ to 30 cases), except for social support with 3.5% missing

Table 2

The odds of reduced demand-specific work ability according to age, gender, and vocational education (mutually adjusted and also adjusted for MSP, MD, and specific job demands/social support). OR=Odds Ratio; 95% CI = 95% Confidence Intervals. The letters in brackets (a–g) refer to the description of the variables measuring demand-specific work ability in Section 2.5. Significant estimates are written in bold face.

	Reduced demand-specific work ability						
	Physical (a)	Amount (b)	Pace (c)	Decision (d)	Memory (e)	Client work (f)	Co-operation (g)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age							
46 years	1.0	1.0	1.0	1.0	1.0	1.0	1.0
56 years	1.3 (1.0–1.6)	1.2 (1.0–1.4)	1.2 (1.0–1.4)	1.3 (1.01–1.6)	1.1 (0.9–1.4)	1.2 (1.0–1.6)	1.3 (1.04–1.7)
Gender							
Male	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Female	0.8 (0.7–1.1)	1.1 (0.9–1.3)	0.9 (0.8–1.1)	0.6 (0.5–0.8)	0.8 (0.6–0.9)	0.6 (0.5–0.8)	0.6 (0.5–0.8)
Vocational education							
None	2.8 (1.4–5.8)	1.7 (1.1–2.7)	1.9 (1.2–2.9)	3.4 (1.9–6.1)	1.9 (1.2–3.2)	3.8 (1.9–7.3)	3.4 (2.0–5.9)
Semi-skilled	2.3 (1.0–5.2)	1.1 (0.6–2.0)	1.4 (0.7–2.5)	3.0 (1.5–5.9)	1.8 (1.0–3.3)	2.5 (1.1–5.7)	2.1 (1.03–4.2)
Skilled	2.1 (1.1–4.2)	1.3 (1.0–1.9)	1.4 (1.0–2.0)	2.2 (1.4–3.6)	1.5 (1.0–2.2)	2.4 (1.4–4.1)	1.8 (1.1–2.8)
Short	2.8 (1.4–5.9)	1.4 (0.9–2.0)	1.4 (0.9–2.1)	1.7 (1.0–3.0)	1.4 (0.9–2.3)	1.9 (1.0–3.5)	1.5 (0.8–2.6)
Middle-ranged	1.9 (0.9–3.8)	1.2 (0.8–1.6)	1.3 (0.9–1.9)	1.8 (1.1–2.9)	1.3 (0.9–2.0)	1.9 (1.1–3.4)	1.3 (0.8–2.2)
Long education	1.0	1.0	1.0	1.0	1.0	1.0	1.0

values ($n = 117$). For all outcome variables (i.e. reduced demand-specific work ability) $\leq 1.5\%$ had missing values ($n = 44$ to 52 cases), except for difficulty working with costumers, patients, or students/pupils with 2.3% missing values ($n = 79$).

For the two variables with the highest percentage of missing values (i.e. 'social support' and 'difficulty working with costumers, patients, or students/pupils') we analyzed if those with missing values differed from those with non-missing values. We found no statistically significant differences for 'social support' with respect to age, gender, and education. For 'difficulties working with costumers, patients, or students/pupils', we found

more missing values ($p = 0.032$) among the 46-year old ($n = 31$, 2.1%) than among the 56-year old ($n = 48$, 3.5%). We also found more missing values ($p < 0.001$) among those with no education ($n = 19$, 10.4%) than among those with a middle-ranged education ($n = 8$, 0.9%).

3. Results

The distribution of gender, vocational education, health, working condition and reduced demand-specific work ability for each age group is presented in Table 1.

Table 3

The association of reduced demand-specific work ability with daily MSP and MD adjusted for age (Model I), age, gender, and length of vocational education (Model II), and age, length of vocational education and job demands/social support (Model III). Significant estimates are written in bold face.

	Model I		Model II		Model III	
	OR	95% CI	OR	95% CI	OR	95% CI
Difficulty managing the physical job demands (physical)						
MSP	1.6	1.2–2.0	1.5	1.2–2.0	1.4	1.1–1.8
MD	2.3	1.4–3.6	2.2	1.4–3.5	1.9	1.2–3.1
High physical job demands					2.0	1.6–2.7
Difficulty managing the amount of work (amount)						
MSP	1.4	1.2–1.8	1.4	1.2–1.7	1.3	1.1–1.6
MD	2.3	1.5–3.5	2.3	1.5–3.4	1.8	1.2–2.8
Demands to accomplish high amounts of work					5.1	4.2–6.2
Difficulty managing the pace of work (pace)						
MSP	1.5	1.2–1.8	1.4	1.1–1.8	1.4	1.1–1.7
MD	3.9	2.6–5.8	3.8	2.5–5.7	3.6	2.4–5.4
High demands to work fast					2.3	1.9–2.8
Difficulty making quick decisions (quick decisions)						
MSP	1.1	0.8–1.4	1.1	0.8–1.4	1.0	0.8–1.4
MD	2.3	1.4–3.7	2.2	1.3–3.6	2.2	1.3–3.5
High demands to make quick decisions					1.5	1.2–2.0
Difficulty remember important things (memory)						
MSP	1.3	1.02–1.6	1.3	1.01–1.6	1.3	1.01–1.6
MD	3.6	2.4–5.4	3.5	2.3–5.4	3.5	2.3–5.3
High memory demands					1.1	0.9–1.5
Difficulty working with costumers etc. (client)						
MSP	1.1	0.9–1.5	1.1	0.8–1.5	1.0	0.8–1.4
MD	1.6	0.9–3.0	1.6	0.9–2.9	1.4	0.8–2.7
High emotional demands					1.5	1.1–2.0
Difficulty working together with colleagues (co-operation)						
MSP	1.0	0.7–1.3	0.9	0.7–1.2	0.9	0.7–1.2
MD	3.0	1.9–4.9	3.0	1.9–4.8	3.0	1.8–4.8
Low social support					1.0	0.8–1.2

3.1. The prevalence of reduced demand-specific work ability

In the group of 46-year old employees, 8–10% of the participants often or always had difficulty making quick decisions, working with customers, patients, or students/pupils, or working together with colleagues (Table 1). In this age-group 12.4% experienced difficulty remembering important things, 14.5% experienced difficulty managing the physical demands of work, and 15.5% experienced difficulty managing the pace of work. Almost one fifth of the 46-year old employees (19.3%) reported difficulty managing the amount of work.

In the group of 56-year old employees 10–12% of the participants often or always had difficulty making quick decisions, working with customers, patients or students/pupils, or working together with colleagues. In this age-group 14.1% experienced difficulty remembering important things, 16.3% experienced difficulty managing the pace of work, and 18.0% experienced difficulty managing the physical demands of work. More than one fifth of the 56-year old employees (21.4%) reported difficulty managing the amount of work.

3.2. The association of age, gender and vocational education with reduced demand-specific work ability

The odds of difficulty making quick decisions and difficulty working together with colleagues were significantly increased among the 56-year old as compared with 46-years old (Table 2). Women had significantly lower odds of experiencing difficulty making quick decisions, remembering important things, working with costumers, patients, or students/pupils, and working together with colleagues (Table 2). Having no vocational education was associated with all measures of reduced demand-specific work ability and for all outcome measures the association was strongest in this exposure group (OR's ranging from 1.7 to 3.8). The most pronounced associations between length of vocational education and reduced demand-specific work ability were observed for difficulty managing physical job demands and making quick decisions and for difficulties working with costumers, patients, or students/pupils and working with colleagues.

3.3. The association of poor health with reduced demand-specific work ability

In the fully adjusted model (Model III, Table 3), we found that MSP was significantly associated with difficulty managing the physical job demands, and the amount and pace of work, and with difficulty remembering important things with odds ratios ranging from 1.3 to 1.4. MD was significantly associated with all measures of demand-specific work ability except for the ability of working with customers, patients, or students/pupils with odds ratios ranging from 1.8 to 3.6. Thus, overall there appeared to be larger associations between MD and measures of reduced demand-specific work ability and additionally, MD was more often related to demand-specific work ability (six out of seven measures) than MSP (four out of seven measures).

3.4. The association of working conditions with reduced demand-specific work ability

In the fully adjusted model (Model III, Table 3), we also found a strong association between demand-specific work ability and high physical job demands (OR = 2.0; 95% CI: 1.6–2.7), demands to accomplish high amounts of work (OR = 5.1; 95% CI: 4.2–6.2), and high demands to work fast (OR = 2.3; 95% CI: 1.9–2.8). Additionally, we found a moderate association between demand-specific work

ability and high demands to make quick decisions (OR = 1.5; 95% CI: 1.2–2.0) and high emotional demands (OR = 1.5; 95% CI: 1.1–2.0).

3.5. The interaction between working conditions and poor health on reduced demand-specific work ability

We found that the combination of MSP/MD and job demands/social support was not associated with more frequent reporting of reduced demand-specific work ability than expected from the product of the individual effects of job demands and health problems (i.e. p for multiplicative interaction >0.05 ; data not shown in tables). Only in one case our analyses showed a significant interaction between job demands (emotional demands) and poor health (MSP) ($p = 0.013$). The interaction worked in the opposite direction than hypothesized: The combination of high emotional demands and MSP was associated with lower odds of reduced demand-specific work ability (i.e. difficulty working with costumers, patients, or students/pupils) than expected from the product of the individual effects of high emotional demands and MSP. The test for additive interaction showed the same results as the test for multiplicative interaction: Only high emotional demands and daily MSP interacted significantly (RERI = -1.1 ; 95% CI: -2.0 to -0.2 ; data not shown in tables).

4. Discussion

4.1. Summary of the results

We found that middle-aged full-time employees most frequently reported difficulty managing the amount of work (about 20%) and most seldom reported difficulty working with costumers etc. and working together with colleagues (about 10%). The oldest age group showed 30% increased odds of difficulty making quick decision, and working together with colleagues. Women less frequently reported reduced demand-specific work ability as compared with men, and in general the odds of reduced demand-specific work ability increased with decreasing length of vocational education being especially high among those without any vocational education.

We found that MD was significantly associated with six out of the seven measures of demand-specific work ability, and, thus, the effect was not as specific as hypothesized. An explanation could be that depressive core symptoms like loss of interest and energy might interfere with any kind of work demand (Adler et al., 2006). MSP was associated with four out of the seven measures of reduced demand-specific work ability. As with MD, the associations between MSP and reduced demand-specific work ability were less specific than hypothesized (i.e. not only associated with difficulties managing physical job demands) as MSP was also associated with difficulty remembering important things. The reason for this finding may be that persons with MSP perceive cognitive impairment as result of attention deficit caused by persistent pain, which could interfere with cognitive demands (Oosterman et al., 2011). Interestingly, neither MSP nor MD was significantly associated with perceived difficulty working with customers, patients, or students/pupils. This finding may, for example, be due to strong selection out of client work or that the work tasks related to client work have been adapted to the employee's mental and physical limitations.

This study did not confirm the hypothesis of an interaction between working conditions and poor health in relation to demands-specific work ability. Analyses of both multiplicative and additive interaction showed non-significant results, with one exception that was in the opposite direction of what we hypothesized, and due to

the number of statistical tests it is likely that this interaction between emotional demands and MSP was a chance finding.

4.2. Comparison with previous research

In line with our findings, a recent review concluded that poor work ability is associated with high mental work demands and high physical workload (van den Berg et al., 2009). Yet, our measures of work ability were related to different, specific job demands.

Our results also support the newer findings of an association between MSP and poor physical, mental, and general work ability (Miranda et al., 2010; Neupane et al., 2013). Musculoskeletal disorders have also been associated with being only ‘partially able’ or ‘unable to work’ (Martimo et al., 2007), and back pain has been associated with poor work ability two years later (Karlsson et al., 2010). Our findings of associations between MD and reduced demand-specific work ability support the previous reports of an association between mental disorders and being only ‘partially able’ or ‘unable to work’ (Martimo et al., 2007) and the effect of good mental health on general work ability (van de Vijfeijke et al., 2013).

With respect to the effect of working conditions on work ability, the literature indicates that high mental workload, high physical workload, and low social support are important factors with respect to reduced work ability (Martimo et al., 2007; van den Berg et al., 2008; van den Berg et al., 2009). In the present study, we found associations between demand-specific work ability and high physical demands, demands to accomplish high amounts of work, high demands to work fast and to make quick decision, and high emotional demands even when adjusting for poor health. Thus, even among full-time employees there appear to be mismatches between job demands and work ability.

One previous prospective study analyzed combinations of job demands and multi-site pain and their interaction. The study found that multi-site pain predicted poor general work ability even when physical and psychosocial working conditions were favorable. In contrast, only ‘awkward postures’ appeared to influence work ability in employees without multi-site pain. (Neupane et al., 2013). As in our study, the Neupane et al. study (2013) did not find support for the hypothesis that demanding working conditions exacerbate the effect of poor health on work ability.

4.3. Strengths and limitations

The strength of the study lies in its large sample encompassing middle-aged full-time employees of both genders with various educational levels and with a rather stable connection to the labor market. The participants were not asked to take their health status into consideration when reporting if they had difficulty managing the seven specific job demands.

The questions on working conditions concerned the frequency of exposure and the questions on demands-specific work ability concerned whether the participants’ have difficulty accomplishing the demands of the job. Still, our study is limited by its cross-sectional design with self-reported exposures and outcomes, and at least three simultaneously operating ‘processes’ may bias the results of the present study: First, participants not being able to accomplish certain demands may be assigned to other less demanding tasks (i.e. selection). Second, poor demand-specific work ability could increase the risk of overreporting the job demands (i.e. differential misclassification).

Third, high job demands may be both a cause and a consequence of reduced demand-specific work ability (i.e. reverse causation). The latter is of special importance regarding the scale measuring the demands of accomplishing high amounts of work, as the

participants are asked ‘Does it happen that you do not complete all your work tasks?’ and ‘Do you get behind with your work?’. The interpretation of these demand-questions is ambiguous as the reason for not completing work tasks or getting behind with work could both be related to working conditions (e.g. imbalance between number of tasks and the assigned time) and to the employee’s ability accomplish the assigned tasks fast enough (i.e. work ability). Also, the experience of high emotional demands could be both a cause and a consequence of difficulty working with customers, clients, or students/pupils. Finally, the experience of low social support in terms the opportunity to get help and support from colleagues and colleagues being willing to listen to problems at work could be both a cause and a consequence of difficulty working together with colleagues.

Poor health, especially MD, may influence both the perception of job demands and work ability negatively (Stansfeld and Candy, 2006). Thus, combinations of self-reports and objective assessments would improve the evaluation of employee work ability. For example, a recent study showed that, in patients with musculoskeletal disorders, performance-based measures predicted work participation (Kuijer et al., 2012). Still, we suggest that the individual’s own perception of the ability to manage specific job demands is of utmost importance for actual performance.

To reduce the risk of residual and unmeasured confounding, we only included respondents with full-time employment, as, for example, it is likely that part-times and full-timers respond differently to questions about the frequency of exposures in the working environment. The drawback of such a restriction of the study population is reduced power and limitations in generalizability. The relatively small differences in demand-specific work ability between the 46-years old and the 56-years old group may be due to that the oldest group is more selected than the youngest group (the healthy worker effect). Caused by the cross-sectional design, the present study could not shed light on selection processes into and out of (full-time) employment. Nevertheless, we showed that signs of reduced ability to manage specific job demands appear even in a sample of full-time employees who should ideally be part of the workforce for another 10–20 years depending on the age of retirement.

As even moderately reduced work ability predicts future disability and death (von Bonsdorff et al., 2011) our findings point to the importance of early initiatives to detect and intervene against poor work ability and its potential causes, e.g. poor health and high job demands. One way of intervening could be a reduction of depressive symptoms and better matching of job demands with the employee’s physical and mental resources. Additionally, recent studies indicate that internal health-related control beliefs moderate the associations between work-related stressors and work ability (Bethge and Radoschewski, 2010), and job control appears to buffer the relation between poor work ability and productivity loss at work (van den Berg et al., 2011). Another recent study found that active coping increased the positive effect of good mental health on work ability and that avoidant coping increased the negative effect of poor mental health on work ability (van de Vijfeijke et al., 2013). Thus, whereas there is no evidence of an interaction between job demands and health, coping styles may influence the effect of mental health on work ability.

5. Conclusion

In conclusion, we found that middle-aged full-time employees reported most difficulty managing the physical demands and difficulty managing the amount of work and pace of work. In general, there was only small to moderate differences between age groups and gender with respect to reduced demand-specific work ability

and in general shorter vocational education was associated with higher odds of reduced demands-specific work ability.

MD had larger associations with reduced demand-specific work ability than MSP. However, both MSP and MD were related to difficulty managing physical job demands, difficulty managing the amount and pace of work, and difficulty remembering important things. Furthermore, MD was associated with difficulty making quick decisions and difficulty working together with colleagues. Thus, the associations between poor health and reduced demand-specific work ability were less specific than we hypothesized.

This study did not confirm an interaction between working conditions and poor health with regard to demand-specific work ability, i.e. high job demands or low social support did not appear to increase the association between poor health and reduced demand-specific work ability.

Authors' contribution

- Idea, formulation of study:* Kirsten Nabe-Nielsen, Karsten Thielen, Else Nygaard, Finn Diderichsen
- Design and collection of data:* Karsten Thielen, Else Nygaard, Finn Diderichsen
- Choice of statistical methods, data processing and statistics:* Kirsten Nabe-Nielsen, Karsten Thielen
- Writing of manuscript:* Kirsten Nabe-Nielsen, Karsten Thielen, Sannie Vester Thorsen
- Critical review and revision of the manuscript:* All authors

Conflicts of interest

The authors report no conflicts of interest.

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References

- Adler, D.A., McLaughlin, T.J., Rogers, W.H., Chang, H., Lapitsky, L., Lerner, D., 2006. Job performance deficits due to depression. *Am. J. Psychiatry* 163 (9), 1569–1576.
- Bech, P., Rasmussen, N.A., Olsen, L.R., Noerholm, V., Abildgaard, W., 2001. The sensitivity and specificity of the major depression inventory, using the present state examination as the index of diagnostic validity. *J. Affect Disord.* 66 (2–3), 159–164.
- Bethge, M., Radoschewski, F., 2010. Physical and psychosocial work stressors, health-related control beliefs and work ability: cross-sectional findings from the German sociomedical panel of employees. *Int. Arch. Occup. Environ. Health* 83 (3), 241–250.
- Burr, H., Bjorner, J.B., Kristensen, T.S., Tuchsén, F., Bach, E., 2003. Trends in the Danish work environment in 1990–2000 and their associations with labor-force changes. *Scand. J. Work Environ. Health* 29 (4), 270–279.
- Christensen, U., Schmidt, L., Kriegbaum, M., Hougaard, C.O., Holstein, B.E., 2006. Coping with unemployment: does educational attainment make any difference? *Scand. J. Public Health* 34 (4), 363–370.
- de Zwart, B.C.H., Frings-Dresen, M.H.W., van Duivenbooden, J.C., 2002. Test-retest reliability of the work ability index questionnaire. *Occup. Med.* 52 (4), 177–181.
- Deyo, R.A., Weinstein, J.N., 2001. Primary care – low back pain. *New. Engl. J. Med.* 344 (5), 363–370.
- Elinson, L., Houck, P., Marcus, S.C., Pincus, H.A., 2004. Depression and the ability to work. *Psychiatr. Serv.* 55 (1), 29–34.
- Karlsson, N., Skargren, E., Kristenson, M., 2010. Emotional support predicts more sickness absence and poorer self assessed work ability: a two-year prospective cohort study. *Bmc Public Health* 10, 648.
- Kessler, R.C., Barber, C., Beck, A., Berglund, P., Cleary, P.D., McEnas, D., Pronk, N., Simon, G., Stang, P., Ustun, T.B., Wang, P., 2003. The world health organization health and work performance questionnaire (HPQ). *J. Occup. Environ. Med.* 45 (2), 156–174.
- Knol, M.J., VanderWeele, T.J., Groenwold, R.H., Klungel, O.H., Rovers, M.M., Grobbee, D.E., 2011. Estimating measures of interaction on an additive scale for preventive exposures. *Eur. J. Epidemiol.* 26 (6), 433–438.
- Kuijer, P.P.F.M., Gouttebarger, V., Brouwer, S., Reneman, M.F., Frings-Dresen, M.H.W., 2012. Are performance-based measures predictive of work participation in patients with musculoskeletal disorders? A systematic review. *Int. Arch. Occup. Environ. Health* 85 (2), 109–123.
- Lerner, D., Amick, B.C., Rogers, W.H., Malspeis, S., Bungay, K., Cynn, D., 2001. The work limitations questionnaire. *Med. Care* 39 (1), 72–85.
- Lundberg, M., Fredlund, P., Hallqvist, J., Diderichsen, F., 1996. A SAS program calculating three measures of interaction with confidence intervals. *Epidemiol.* 7 (6), 655–656.
- Martimo, K.P., Varonen, H., Husman, K., Viikari-Juntura, E., 2007. Factors associated with self-assessed work ability. *Occup. Med.* 57 (5), 380–382.
- Martinez, M.C., Latorre, M.D.D.D., 2006. Health and work ability among office workers. *Rev. Saude Publica* 40 (5), 851–858.
- McCracken, L.M., Samuel, V.M., 2007. The role of avoidance, pacing, and other activity patterns in chronic pain. *Pain* 130 (1–2), 119–125.
- McDermott, L.M., Ebmeier, K.P., 2009. A meta-analysis of depression severity and cognitive function. *J. Affect Disord.* 119 (1–3), 1–8.
- Miranda, H., Kaila-Kangas, L., Heliövaara, M., Leino-Arjas, P., Haukka, E., Liira, J., Viikari-Juntura, E., 2010. Musculoskeletal pain at multiple sites and its effects on work ability in a general working population. *Occup. Environ. Med.* 67 (7), 449–455.
- Munir, F., 2008. The work limitation questionnaire. *Occup. Med.* 58 (4), 310–311.
- Neupane, S., Virtanen, P., Leino-Arjas, P., Miranda, H., Siukola, A., Nygaard, C.H., 2013. Multi-site pain and working conditions as predictors of work ability in a 4-year follow-up among food industry employees. *Eur. J. Pain.* 17 (3), 444–451.
- Oosterman, J.M., Derksen, L.C., van Wijck, A.J., Veldhuijzen, D.S., Kessels, R.P., 2011. Memory functions in chronic pain: examining contributions of attention and age to test performance. *Clin. J. Pain.* 27 (1), 70–75.
- Pejtersen, J.H., Kristensen, T.S., Borg, V., Bjorner, J.B., 2010. The second version of the Copenhagen psychosocial questionnaire. *Scand. J. Public Health* 38, 8–24.
- Stansfeld, S., Candy, B., 2006. Psychosocial work environment and mental health – a meta-analytic review. *Scand. J. Work Environ. Health* 32 (6), 443–462.
- Tengland, P.A., 2011. The concept of work ability. *J. Occup. Rehabil.* 21 (2), 275–285.
- van de Vijfeijke, H., Leijten, F.R., Ybema, J.F., van den Heuvel, S.G., Robroek, S.J., van der Beek, A.J., Burdorf, A., Taris, T.W., 2013. Differential effects of mental and physical health and coping style on work ability: a 1-year follow-up study among aging workers. *J. Occup. Environ. Med.* 55 (10), 1238–1243.
- van den Berg, T.I., Alavinia, S.M., Bredt, F.J., Lindeboom, D., Elders, L.A., Burdorf, A., 2008. The influence of psychosocial factors at work and life style on health and work ability among professional workers. *Int. Arch. Occup. Environ. Health* 81 (8), 1029–1036.
- van den Berg, T.I., Robroek, S.J., Plat, J.F., Koopmanschap, M.A., Burdorf, A., 2011. The importance of job control for workers with decreased work ability to remain productive at work. *Int. Arch. Occup. Environ. Health* 84 (6), 705–712.
- van den Berg, T.I.J., Elders, L.A.M., de Zwart, B.C.H., Burdorf, A., 2009. The effects of work-related and individual factors on the work ability index: a systematic review. *Occup. Environ. Med.* 66 (4), 211–220.
- von Bonsdorff, M.B., Seitsamo, J., Ilmarinen, J., Nygard, C.H., von Bonsdorff, M.E., Rantanen, T., 8-3-2011. Work ability in midlife as a predictor of mortality and disability in later life: a 28-year prospective follow-up study. *CMAJ* 183 (4), E235–E242.